base towards the tip. The shaft is yellowish white for about half its length from the base, with a line of dark brown along the side next to the inner web, becoming generally darker brown as it approaches the tip.

The general colour of the tail-feather is dark ashy grey, becoming reddish on the outer and brownish on the inner web, dotted throughout with small white spots. Along both webs, near the shafts, extending from the base for two-thirds the length of the feather, are numerous rather large reddish spots with black centres, generally of an oblong form, but lengthened out into lines towards the margins; near the tip these reddish markings disappear entirely. The shaft is reddish, blackish brown on the side of the outer web. The feather is very broad, graduating to a sharp point at the tip; its total length is about 4½ feet.

These feathers do not resemble in any particular that of the *A. bipunctatus* described lately by Mr. Wood. I shall give full-size representations of all the feathers in my Monograph of the Phasianidæ, now publishing.

XVII.—*On the Constitution of Milk and Blood.* By M. Dumas*.

During the most troubled years of the first French revolution, the old Academy of Sciences of Paris having been suppressed, its members none the less continued their patriotic cooperation in the labours required by the new necessities of the country. History has given them credit for this. It associates the names of the principal of them with those of the illustrious administrators and generals, who then caused the integrity of the French soil to be respected.

The editors of the 'Annales de Chimie,' who had been compelled to suspend their publication under the reign of Terror, on resuming it had the happy thought of collecting, in two volumes, all the memoirs or reports with which the Academicians had been charged. In running through these we appreciate at a glance the importance of the questions which were addressed to them, the insufficiency of the means at their

* Translated by W. S. Dallas, F.L.S., from the 'Bibliothèque Universelle,' 15 June 1871, Archives des Sciences, pp. 105–119. This paper has been extracted from the 'Philosophical Magazine' for August, as, although its subject does not strictly belong to natural history, some of the author's observations will be of interest to naturalists at the present time.

command during those troublous times, and the merits of the practical solutions which they presented to the country, as the fruit of their previous studies, or of their improvised experiments.

Saltpetre, gunpowder, steel, weapons, gun-metal, potash, soda, soaps, paper, assignats, and many other objects implicated in the defence of the country, the working of its manufactures and the necessaries of life, gave occasion to investigations and discoveries of which the factories have not yet forgotten the tradition.

The siege of Paris by the Prussian army could not, it was said, be sufficiently prolonged to raise any questions of the same kind; but nevertheless it has been necessary, as in the time of our fathers, to seek for nitrated earths, to produce gunpowder, to manufacture and work up steel, to obtain bronze and cast cannon; we also have been in want of paper, and of a great number of useful objects.

Considerable, although rapid, investigations have been accomplished; and it will be useful as well as just not to allow their memory to be lost. I have busied myself in collecting the materials for this publication, which I shall carry out as soon as circumstances will permit.

Among the privations which our forefathers did not know in their most cruel intensity, those which caused the most decided sufferings to the existing population, relate to the want of combustibles, which was rendered intolerable and most destructive by an exceptionally rigorous winter—to the scarcity of milk and eggs, the certain cause of the premature decease of a great number of young children—and, finally, to the exhaustion of the supplies of corn, flour, and meat, which, rendering the capitulation of Paris inevitable, marked the precise day for it.

Three questions, which have occupied the mind of every man curious to foresee the future of science, were thus incessantly presented to the meditation of the scientific men shut up in Paris, not as far-away dreams in which the imagination delights and disports itself, but as the despairing prayers of a people in utter extremity:—

1. To obtain available heat, without combustibles;
2. To reconstruct food with mineral materials, without the cooperation of life;
3. To reproduce, at least, the essential food of man with non-alimentary organic materials.

Man, in warming himself by means of combustibles furnished either by the existing vegetation, or by the remains of the ancient vegetation of the globe, and in nourishing himself by means of products obtained from plants and animals, demands every thing from life; but could he dispense with life in obtaining his combustible and his nutriment? Would the forces of science alone suffice to assure to him, in this urgent need, those satisfactions which he could no longer demand from the forces of living nature?

This was the question. If put in a time of peace and in the midst of abundance, it would probably have received more than one response in the affirmative. The progress of the physical sciences has been so brilliant! One is so much disposed to exaggerate their power! Electricity opens up such seductive perspectives! Synthesis has produced so many marvels in the hands of chemists!

If the necessity had not been so pressing, so that the question might have been raised as a philosophical thesis, and we could have said to the physicists and chemists, Could you not, if it were necessary, furnish man with heat and food without having recourse to plants and animals? how many, without saying *yes*, would, at least, have answered with one of those smiles which do not say *no*.

But in a crisis where it was necessary to realize immediately what would have been left to hope, people showed reserve; radical solutions were adjourned, and there was no question either of heating Paris without combustibles, or of feeding it without organic aliments.

But could organic materials usually disdained be converted into aliments, so as to replace, by means of clever combinations, those natural products which could no longer be procured?

It is not my design to notice what viands were served at table, or what resources we were led to seek in the blood and offal of the slaughter-houses which are usually thrown away, the bones, feet, and even the skins of the cattle slaughtered. Nor will I examine how the butter and lard, which were speedily exhausted, were replaced. Of these improvised arts some have disappeared with the circumstances which gave them birth, whilst others have left some useful teachings.

I shall treat only of a special question, the solution of which involved certain principles which it seems to me to be important to guard. Was it not possible to come to the assistance of new-born children by replacing the milk, which could no longer be got, by some saccharine emulsion? In this case there was no question of creative chemistry, but only of culinary chemistry. Recipes were not wanting, all reproducing an albuminous liquid, sugar, and an emulsion of a fatty body.

As a provisional succedaneum this artificial milk deserved to be welcomed. But sometimes there was such a conviction in the authors of these propositions, that one was forced to dread for the future the effects of their faith. This was of a nature to make too many proselytes, to the great injury of the children at nurse, and the great profit of the dealers in milk. How could the latter have the least scruple when they were taught to manufacture an emulsion which they saw recommended to the consumers, and even to mothers, as the real equivalent of milk?

The services rendered by concentrated milk during the siege were too important to render any excuse necessary in the country which produces it, when we insist upon the preference always due to natural milk, as also upon the characters which at present do not permit us to confound any artificial milky liquid whatever with the truly secreted product.

Natural milk forms a liquid containing salts, sugar, caseum in solution, and fatty globules in suspension. Let us first see whether we can imitate these fatty globules by dividing or making an emulsion of an oily or fatty matter in a viscous liquid.

I believe that I experimentally demonstrated the contrary some years ago by showing that the globules of fatty matter of milk are protected from certain physical or chemical reactions by a true membranous envelope. Admitted by some, and disputed by others, the existence of this membrane seeming to me to be real and proven, there could be no question, in my opinion, about confounding an artificial emulsion with naked fatty globules with milk from the mammæ, presenting fatty globules enveloped by a membrane, true free cells, filled with butter, analogous to the agglutinated cells of adipose tissues.

The existence of this membrane may be proved by two chemical experiments.

The first depends upon the property possessed by sulphuric ether of dissolving fatty matters and collecting together those which are suspended in liquids, provided that they are free. Now if, after shaking together in a tube fresh milk and ether, they are left to rest, the ether floats on the surface without having dissolved any thing, and the milk resumes its place below the ether without having lost any thing of its appearance, or yielded any of its buttery matter.

But when subjected beforehand to the action of acetic acid, which is able to dissolve the envelopes of its fatty globules, milk, when shaken up with ether, loses its opacity, and yields its butter to that liquid, in which it may be found.

An inverse test leads to the same conclusions. A neutral salt, such as sulphate of soda, added to milk, enables us to filter it, and to retain upon the filter the globules of butter, whilst the serosity flows off perfectly limpid and clear. If the washings with saline water be continued, these globules may be freed from all the soluble products of the serum. Now if the butter consisted of simple fatty globules, there would then remain with them no trace of albuminous or caseous matter. But whatever care may be taken to prolong the washings, we always find with the fatty matter such a proportion of albuminized substance that there can be no doubt that it has remained there in the form of those envelopes or cells which constitute the globules of butter.

The microscope, moreover, shows plainly the constitution of the globules of butter, and reveals the constant presence of the envelopes. It is sufficient to crush the globules of milk by means of the compressor, to obtain a conviction that, after the spreading of the fatty matter, the butter-cell still retains its form and outline, thus showing that the contents and the container have each their distinct existence.

For these reasons, and for many others (for no conscientious chemist can assert that the analysis of milk has made known all the products necessary to life which that aliment contains), we must renounce, for the present, the pretension to make milk, and especially abstain from assimilating any emulsions to this product.

Besides we cannot have too much reserve where we have to pronounce upon the identity of two products, one natural, the other artificial, if they are not crystallizable or volatile—that is to say, definite. We can never affirm that we have reproduced a mineral water, or sea-water for example. When manure for plants, or aliments for man and animals are in question, is not the same reserve still more imperative?

These indefinite natural mixtures contain substances which the coarsest analysis discovers, with others less strongly characterized or less abundant, which are only revealed by delicate chemistry, and others again, and perhaps the most essential, which still escape us, either because they exist in infinitesimal proportions, or because they belong to the category of bodies which have not hitherto been distinguished from other chemical species.

It is therefore always prudent to abstain from pronouncing upon the identity of these indefinite mixtures employed in the sustenance of life, in which the smallest and most insignificant traces of matters may prove to be not only efficacious, but even indispensable. In proportion as science extends her domain, we are sure to see the demonstrations of the appropriateness of this reserve multiplied.

Among the fine investigations executed in France by those who have continued the labours which occupied the life of the illustrious Théodore de Saussure, the important thesis of M. Raulin upon the vegetation of *Aspergillus niger* will always be placed in the foremost rank. All the conditions of the life of this Mucedinean have been so well determined by that author that it may be cultivated with precision in a soil formed of definite chemical species, as if we had to do with the formation of a compound; and the soil once sown, we may follow the transformation or the employment of each of the elements necessary to its life, just as if we had to do with the development of an ordinary chemical equation.

Now, who could have foreseen that the *Aspergillus niger*, which has just made its appearance, for example, upon a slice of lemon exposed to the air, required for the fulness of its existence traces of *oxide of zinc*? How, after this, can we doubt, in the case of plants of a higher order and especially of animals, that, besides their coarsely appreciable aliments, they require also traces of many other aliments, more delicately used but not less necessary?

Milk has often been compared to eggs, both from a chemical and a physiological point of view. Their mission is equally to furnish the young animal with the nourishment of its earliest age; and they have as a common character that they present in union a fatty matter, an albuminoid substance, a saccharine or amylaceous matter, and salts.

But the egg possesses a vitality, an organization, of which chemistry furnishes no evidence, and which the most minute anatomy would be powerless to reveal. If fecundation had not rendered manifest, by the rapid phenomena of segmentation which take place in it, that the mass of the yelk of an egg is endowed with life, and that it obeys the impulsion of the living germ which takes possession of it, we should still be ignorant that the yelk of the egg is not a mere emulsion of inert fatty matter.

Is not milk in the same case? One is led to think so when we see that the yelk of the egg and milk have the same destination and the same configuration, and that, if the yelk obeys the action of the germ which is nourished by it, milk, for its part, proves to be singularly ready to receive and nourish germs of more than one kind, which, on reaching it, become developed and live at its expense.

The power of synthesis of organic chemistry in particular, and that of chemistry in general, have therefore their limits.

The siege of Paris will have proved that we have no pretension to make bread or meat from their elements, and that we must still leave to nurses the mission of producing milk. If some illusions upon this point have found their way into the minds of persons ill-informed as to the true state of science, they are due to the dangerous play of words to which the expressions *organic chemistry* and *organic substances* lend themselves, when applied as these are indifferently to definite compounds such as alcohol or citric acid, which are unfitted for life, and to indefinite tissues, the seat of life.

The former (foreign to life, and true chemical species) are the only ones that synthesis has reproduced. The latter, which can be formed only under the impulse of a living germ, and which receive, preserve, and transfer the forces of life, are not definite species; the synthesis of the laboratories does not reach them. The only synthesis which has hitherto been observed in the case of the chemical materials which constitute living tissues, is that determined in brute matter by the presence and impulse of the living germ itself.

All those chemical syntheses, otherwise so worthy of interest, which have been indicated as reproducing organic matters, have therefore in reality reproduced only matters unfitted for life—that is to say, mineral matters. Thus, of every living matter or matter that has lived, we must still, whether we speak as chemists or as physiologists, say what was said of it formerly: *omne vivum ex ovo*—that which is not life has brought nothing to life.

With regard to the constitution of milk, the phenomena presented by the clarifying of butter have been sometimes employed either to demonstrate or to dispute the existence of the membranes which envelope the butyrous globules; I cannot at present regard these phenomena as having any value in this respect.

It has been said, for example, that the separation of butter was the result of the formation of lactic acid arising from the action of the air, favoured by churning. Numerous experiments effected in my laboratory upon a practical scale, have shown that butter separates equally promptly, and at least equally abundantly, from a milk to which a large amount of bicarbonate of soda has been added, as from natural milk. The alkaline reaction of the former, which is maintained during the operation and after its completion, has no influence either upon its duration or its result. The proportion of butter, far from being diminished, seems even to have been increased by it.

The formation of lactic acid is therefore not necessary for the separation of butter, which appears to me to be due to purely mechanical causes. Such, at least, is the feeling that one experiences on examining by the microscope milk submitted to churning whilst the operation is going on. The first test-drops present nothing peculiar; the globules of butter retain their form, dimensions, and aspect. Soon we see appear irregular butyrous islands in the midst of globules remaining unaltered. These islands of butter increase in number and extent in proportion as the operation proceeds. They form a snow-ball, uniting with each other and becoming agglomerated so as to constitute, at last, the mass of butter which is the object of the operation.

The agglomeration of the butyrous globules into a block of butter would be a true regelation if there were no membrane surrounding them. The existence of this compels us to admit that it must be broken, and that this is the object of the repeated shocks which we make the liquid undergo, in order that the diffused butter may unite with the fatty parcels and agglomerations which it meets with on its road.

If it is true that the separation of butter is a purely mechanical phenomenon, it is not the less so, as I shall hereafter show, because chemistry can give rules to render this operation more rapid and more efficacious, and to produce from it a better clarified and less alterable butter.

I conclude this communication with some details upon phenomena of another nature, towards which the hygienic situation of the inhabitants of besieged Paris turned one's thoughts only too naturally. What took place in the tissues of this population deprived of fresh vegetables, fruits, milk, fish, and fresh meat? What changes did the blood undergo under the influence of this diet? and how must they manifest themselves?

Some years ago I had prepared some experiments the object of which was to ascertain whether exchanges by exosmose and endosmose take place between the internal liquids contained in the globules of the blood and the liquids of the serum. If these exchanges were easy and rapid, their existence might be ascertained. To demonstrate them would be to ascertain by what means the constitution of the globules of the blood may be altered and vitiated, reestablished, or regenerated.

I never completed these experiments; but I have often depended upon the views which guided me, in order to make my auditors in my courses at the faculty of medicine understand how certain alterations of the blood might be interpreted.

It is necessary, perhaps, to explain what stopped me.

Nothing is easier than to compare the serum and globules of a normal blood with the serum and globules of the same blood modified by the intervention of a substance capable of changing the direction or the intensity of the powers of endosmose between the globules and the serum.

In the blood of a living animal the globules suspended in the liquid may absorb or lose some of their elements, if we succeed in changing the constitution of the serum; but how long will the phenomenon last? If the substance added be mischievous it will be eliminated; the veins on their part will absorb liquids destined to reestablish the equilibrium, and the experiment will soon be so altered that the little differences that we have to measure will disappear, vanishing before great complications.

On the contrary, if we withdraw the blood from the body of the animal and divide it into two parts of equal weight, one destined to furnish the term of comparison, and the other to receive the substances modificative of the power of endosmose, coagulation and what I have called the asphyxia and death of the globules will soon do away with any hope of arriving at certain results.

It was therefore necessary to receive the blood into a vessel, to oppose its coagulation, and to replace towards it the action both of the heart and lungs—that is to say, to keep the blood in movement and to present it in a very divided state to the action of oxygen or of the air. I arranged an apparatus which fulfilled these conditions, and allowed one to ascertain how alcohol, neutral salts of soda or potash, sugar, &c. act when added to the serum, and how the interior liquids contained in the globules may become modified under their influence either in quantity or in nature.

While I followed out these views, preoccupied by the evident invasion of scurvy in the general state of health of the inhabitants of Paris towards the close of the siege, and whilst I sought to make up by applicable means for the absence of all fresh vegetables and of all fruit in their habitual diet, a foreign doctor, Dr. J. Sinclair, by following out the ideas which he had heard me teach upon this subject, was led to seek in them the explanation of the first symptoms of alcoholism, a state which he designates by the name of dypsomania.

Just as scurvy would have as its primary cause an impoverishment of the serum in potash-salts and a surcharge of salts of soda (which favours the exosmose of the potash of the globules and consequently their destruction), so alcoholism would have as its starting-point the presence of alcohol in the serum of the blood and its effects on the globules.

Alcohol added to the serum causes a movement of exosmose from the interior of the globules to the serum. The globules lose a part of their constituent liquids; and this alteration, which brings on others, is no doubt reproduced in the cells of the various tissues which are bathed by alcoholized liquids.

What it is now my intention to prove is, that in the blood in particular, and in every living organism of analogous constitution (that is to say, formed by cells or utricles filled with a liquid and floating in or bathed by a liquid), it is sufficient to alter, even slightly, the chemical composition of the exterior liquid to cause that of the interior liquid to become modified by endosmose or exosmose.

As soon as I am enabled to resume possession of my laboratory, if I should ever see it again, I propose to follow out the development and application of this principle, either to demonstrate the effects produced by the action of common salt, alcohol, &c. upon the blood, or to show how rapid is that of some agents, of which I have already examined the action, upon the constitution of the globules.

In the mean time I have yielded to the wishes of your eminent President, and I lay upon the table the exposition of those investigations which time may cause to fructify either in my own or more worthy hands. It is a homage that it is a pleasure to my old age to offer to that kind Society which, having, in 1816, guided my youth and the first steps of my career, offers me for the second time, in 1871, after an interval of half a century, the asylum of its friendly hospitality under grievous circumstances to my country.

PROCEEDINGS OF LEARNED SOCIETIES.

ROYAL SOCIETY.

May 11, 1871.—General Sir Edward Sabine, K.C.B., President, in the Chair.

"Action of Heat on Protoplasmic Life." By F. Crace-Calvert, F.R.S.

Those investigators of germ-life who favour the theory of spontaneous generation have assumed that a temperature of 212° Fahr., or the boiling-point of the fluid which they experimented upon, was sufficient to destroy all protoplasmic life, and that the life they subsequently observed in these fluids was developed from non-living matter.

I therefore made several series of experiments, in the hope that they might throw some light on the subject.

The first series was made with a sugar solution, the second with